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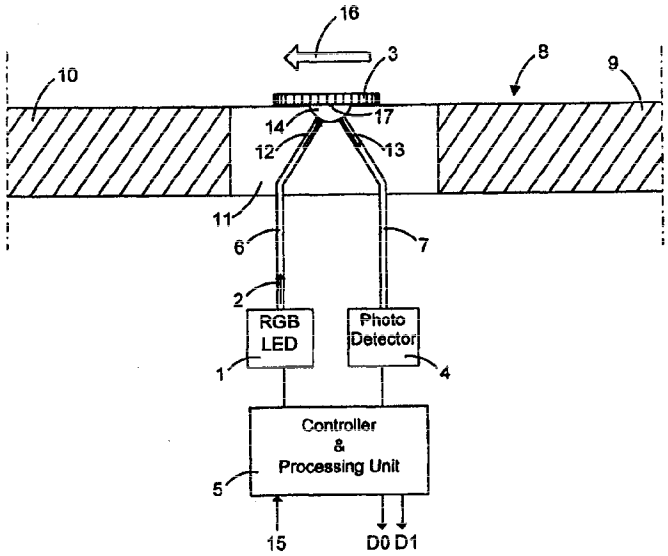

(57) Abstract

A coin discriminating device has light emitting means (1) for projecting light (2) onto a surface of a coin (3), optical sensor means (4) for detecting light reflected from the coin, and processig means (5) for determining a type of the coin by comparing coin data obtained from the optical sensor means with reference data related to different types of coins. The light emitting means (1) is arranged to emit monochromatic light in a visible, infrared or ultraviolet wavelength range. The optical sensor means (4) and the processing means (5) are arranged to produce spectral charateristics data for light reflected from the coin surface and to compare the spectral characteristics data with spectral coin reference data for determining the type of the coin (3).

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COIN DISCRIMINATING DEVICE AND METHOD

Technical Field

The present invention relates to coin discriminators, particularly of the kind comprising light emitting means for projecting light onto a surface of a coin, optical sensor means for detecting light reflected from the coin, and processing means for determining a type of the coin by comparing coin data obtained from the optical sensor means with reference data related to different types of coins. The present invention also relates to a coin discriminating method.

Description of the Prior Art

Coin disciminators are used in e.g. coin sorting/counting machines for identifying the type (e.g. denomination) of each coin that is processed by the machine. Furthermore, coin discriminators are used in coin inspection systems for sorting out foreign coins, fake coins and coins that are unfit for further circulation (due to e.g. excessive wear). Some coin discriminators operate inductively by exposing the coins to an alternating magnetic field by means of one or more than one coil and detecting an electrical characteristic in response to the magnetic field exposure, for instance the decay of eddy currents induced in the coin.

Inductive coin discriminators are often able to successfully identify the metallic composition of the coin, thereby allowing a determination of the coin denomination by additionally using measurement data related to e.g. the coin diameter. However, not all coin types are distinctive enough, in terms of their magnetic and electric characteristics, to allow differentiation by means of an inductive coin discriminator. For instance, prior art discriminators

have failed to differentiate 20 NOK Norwegian coins from 50 GRD Greek coins.

A different and considerably more expensive kind of coin discriminators is optical pattern recognition discriminators, which produce e.g. a grey-scale photograph of the coin surface and identify the coin type by image analysis methods and comparisons with stored coin reference data. Optical pattern recognition discriminators of this type are shown in EP-A-0 798 669 and EP-A-0 798 670 and comprise light emitting means for projecting light onto a surface of a coin, optical sensor means for detecting light reflected from the coin, and processing means for determining a type of the coin by comparing data obtained from the optical sensor means with reference data related to different types of coins. However, some specific types of coins have similar magnetic and electric characteristics as well as similar surface patterns (coin stamps). To successfully identify also such coins, a combination of inductive and optical pattern recognition discriminators would appear necessary, the obvious drawback being a major cost penalty.

Summary of the Invention

The object of the present invention is to solve the problem set out above and provide accurate identification of coins of different types and denominations, even if their magnetic, electric and surface pattern characteristics are very similar.

The object is achieved for a coin discriminating device as set out above by arranging the light emitting means, the optical sensor means and the processing means to produce spectral characteristics data for light reflected from the coin surface and by comparing the spectral characteristics data thus obtained with spectral coin reference data for determining the type of the coin.

An important aspect of the present invention is the realization that "tricky" coin types as described above may be differentiated by providing a device and a method for determining and evaluating the color of the coin surfaces. Other objects, features and advantages of the present invention appear from the following detailed disclosure, from the drawings as well as from the appended claims.

Brief Description of the Drawing

The present invention will now be described in more detail, reference being made to the accompanying drawings, in which:

FIG 1 is a schematic top view illustrating a preferred embodiment of a coin discriminating device according to the invention,

FIG 2 is a flow chart depicting a preferred embodiment of a method according to the invention, and

FIG 3 is a bar chart diagram of the spectral distribution obtained from the method of FIG 2 for an exemplary coin.

Detailed Disclosure of the Invention

As shown in FIG 1, the coin discriminator according to the preferred embodiment comprises an RGB light emitting diode (LED) 1, which is arranged adjacent to a first end of a first optical fiber 6, the second end 12 of which is connected to a recess 14 in a coin path 8. Furthermore, the coin discriminator comprises a photodetector 4 and a second optical fiber 7, which extends from a first end at the photodetector 4 to a second end 13 at the recess 14. A combined controller and processing unit 5 is operatively connected to the RGB diode 1 and the photodetector 4. The processing unit 5 has a control input 15 and data outputs D0 and D1.

The coin path 8 provides a plane surface, along which a coin 3 may move from a first position 9 to a second position 10 in a direction indicated by an arrow 16 in FIG 1. The coin 3 may be arranged to roll along the path 8, preferably by arranging the path 8 at a declination from the first position 9 towards the second position 10. Alternatively, the coin 3 may be carried along the path 8 by active driving means, such as a belt or a resilient carrier member. A typical application for the inventive coin discriminator will be in a coin counting and/or sorting machine, wherein the path 8 is part of a coin processing stage inside the machine. Coin counting and/or sorting machines as such are common general knowledge and are not described in more detail herein.

According to the preferred embodiment, an additional coin sensor 11 is arranged along the path 8. The additional coin sensor operates inductively for determining type-related coin parameters, such as metal alloy composition. However, the additional coin sensor 11 is well-known per se and does not form an essential component of the present invention. Consequently, the present invention may be applied without the use of such an additional coin sensor 11.

The first and second optical fibers 6 and 7, which in the preferred embodiment have a cross-sectional diameter of about 2 mm, are arranged to illuminate a small spot 17 on the surface of the coin 3 with light 2 emitted by the RGB diode 1 and to receive and forward light reflected from said spot 17 to the photodetector 4. More specifically, the RGB diode 1 comprises three light emitting diode elements integrated as one component and arranged to emit red, green and blue light, respectively. The combined controller and processing unit 5 is arranged to control which of the three colors that will be emitted from the RGB diode 1 at a respective moment. Depending on the color of the surface of the coin 3, the intensity of the light reflected in the

spot 17 will be different for red, green and blue light, respectively.

With reference to FIG 2, a complete measurement is executed as follows. In the beginning, the procedure is initiated by the controller and processing unit 5 in a step 100, wherein internal variables, temporary parameters, etc., are reset. Being controlled by the controller and processing unit 5, the RGB diode 1 then first emits a pulse of red light (in a step 110), the reflection of which is detected in a step 120 by the photodetector 4 and registered by the processing unit 5. Subsequently, the RGB diode 1 emits a pulse of green and blue light in steps 130 and 150, respectively, and the respective reflections are detected and registered by the photodetector 4 and processing unit 5 in respective steps 140 and 160.

Once all three colors have been emitted and detected, the detected reflection intensity values are adjusted in a step 170 according to calibrated values, so as to remove any influences from a defective, dirty or dull coin surface. Preferably, the calibration values are determined for a perfectly white surface and only once, e.g. during the manufacturing of the coin discriminator.

After having corrected the detected reflection intensity values according to the above calibration, the relative distribution of the three colors (red, green and blue) are calculated in a step 180 by the processing unit 5. By accessing an electronic memory operatively connected to the processing unit 5, the unit 5 analyzes and compares, in a step 190, the relative reflection intensity values with a plurality of prestored coin reference data, so as to determine in a step 200 a type of the coin 3 in the form of a surface color. Preferably, the processing unit 5 is arranged to differentiate between at least the colors of copper, silver and gold. The relative distribution of these colors are indicated for an exemplary coin in FIG 3.

When the type or color of the coin 3 has been determined by the processing unit 5, the result of the determination is available at the outputs D0 and D1. According to the preferred embodiment, the outputs D0 and D1 are given values according to the following table:

D1	D0	Meaning
0	0	No coin
0	1	Copper
1	0	Silver
1	1	Gold

The control input 15 is used by other components in e.g. the coin counting and/or sorting device for activating the coin discriminator.

Thanks to the inventive coin discriminator, it is possible to differentiate among coins which are very similar as regards their magnetic and electric characteristics as well as their surface pattern or coin stamp, such as the 20 NOK and 50 GRD coins referred to above, provided that such coins exhibit a difference in surface color. When it comes to the two exemplary coin types above, the 20 NOK coin has a silver color, while the 50 GRD has a gold color.

For enhanced accuracy the measurements may be repeated a number of times for each color. An average reflection intensity value will then be calculated and used by the processing unit 5 for determining the coin type. The preferred embodiment described above operates by emitting narrow-band monochromatic light in three discrete wavelength ranges and by broadly detecting the intensity of the reflected light at the respective wavelength ranges. According to an alternative embodiment, the emitting diode 1 is instead arranged to emit white or broadband light, wherein the photodetector 4 is arranged to operate in narrow bands around a few discrete wavelengths, such as red, green and

blue light. Furthermore, the coin discriminator may operate with less than three colors or with more than three colors, as will be readily realized by a man skilled in the art. However, for accurate coin discrimination, the best solution is believed at the moment to involve the use of at least three different colors.

The light emitted by the diode 1 may range from ultraviolet light to infrared light, i.e. the present invention is not limited to the use of wavelengths within the visible range.

The invention has been described above with reference to a few embodiments, the purpose of which is to exemplify the invention but in no way to limit the same. Therefore, the invention may be carried out in other ways than the ones described above, and the scope of the invention is only limited by the appended independent patent claims.

CLAIMS

1. A coin discriminating device, comprising: light emitting means (1) for projecting light (2) onto a surface of a coin (3); optical sensor means (4) for detecting light reflected from the coin; and processing means (5) for determining a type of the coin by comparing coin data obtained from the optical sensor means with reference data related to different types of coins, **characterized** in that

the light emitting means (1) is arranged to emit monochromatic light in a visible, infrared or ultraviolet wavelength range, and in that

the optical sensor means (4) and the processing means (5) are arranged to produce spectral characteristics data for light reflected from the coin surface and to compare the spectral characteristics data with spectral coin reference data for determining the type of the coin (3),

2. A coin discriminating device as in claim 1, further comprising means for forming a path (8), along which said coin (3) travels from a first position (9) to a second position (10).

3. A coin discriminating device as in claim 2, wherein said path (8) comprises a coin detector (11) different from the optical sensor means (4).

4. A coin discriminating device as in claim 2 or 3, further comprising a first light guiding means (6) arranged between the light emitting means (1) and said path (8).

5. A coin discriminating device as in claim 4, further comprising a second light guiding means (7) arranged between the optical sensor means (4) and said path (8).

6. A coin discriminating device as in claim 4 or 5, wherein a respective end (12, 13) of the first and second light guiding means (6, 7) is arranged adjacent to a recess (14) in said path (8).

7. A coin discriminating device as in any of claims 4-6, wherein the first and/or second light guiding means (6, 7) comprise(s) an optical fiber.

8. A coin discriminating device according to any preceding claim, wherein the light emitting means (1) comprises at least one light emitting diode (LED).

9. A coin discriminating device according to any preceding claim, wherein the processing means (5) is arranged to provide an output signal indicative of one of a copper surface, a silver surface or a gold surface of the coin (3).

10. A coin discriminating method, wherein: a surface of a coin (3) is irradiated with light (2); light reflected from the coin surface is detected; reflection data related to at least a portion of the coin surface is produced from the reflected light; and a type of the coin is determined by comparing the reflection data with reference data related to a plurality of coin types, **characterized** in that the coin (3) is irradiated with monochromatic light (2), and in that the reflection data and the reference data relate to the spectral characteristics of coin surfaces when exposed to monochromatic light.

11. A method as in claim 10, comprising the steps of: illuminating a spot (17) on the coin surface with monochromatic light of a first color and detecting a first reflection thereof; illuminating said spot with monochromatic

light of a second color and detecting a second reflection thereof; illuminating said spot with monochromatic light of a third color and detecting a third reflection thereof; determining a relative distribution of the first, second and third reflections; and determining the type of the coin (3) from said relative distribution.

12. A method as in claim 11, wherein the first, second and third colors comprise red, green and blue.

13. A method as in any of claims 10-12, wherein said coin type relate to the color of the coin surface.

14. A method as in any of claims 10-13, wherein said coin type is determined as one of a copper color, a silver color or a gold color.

FIG 1

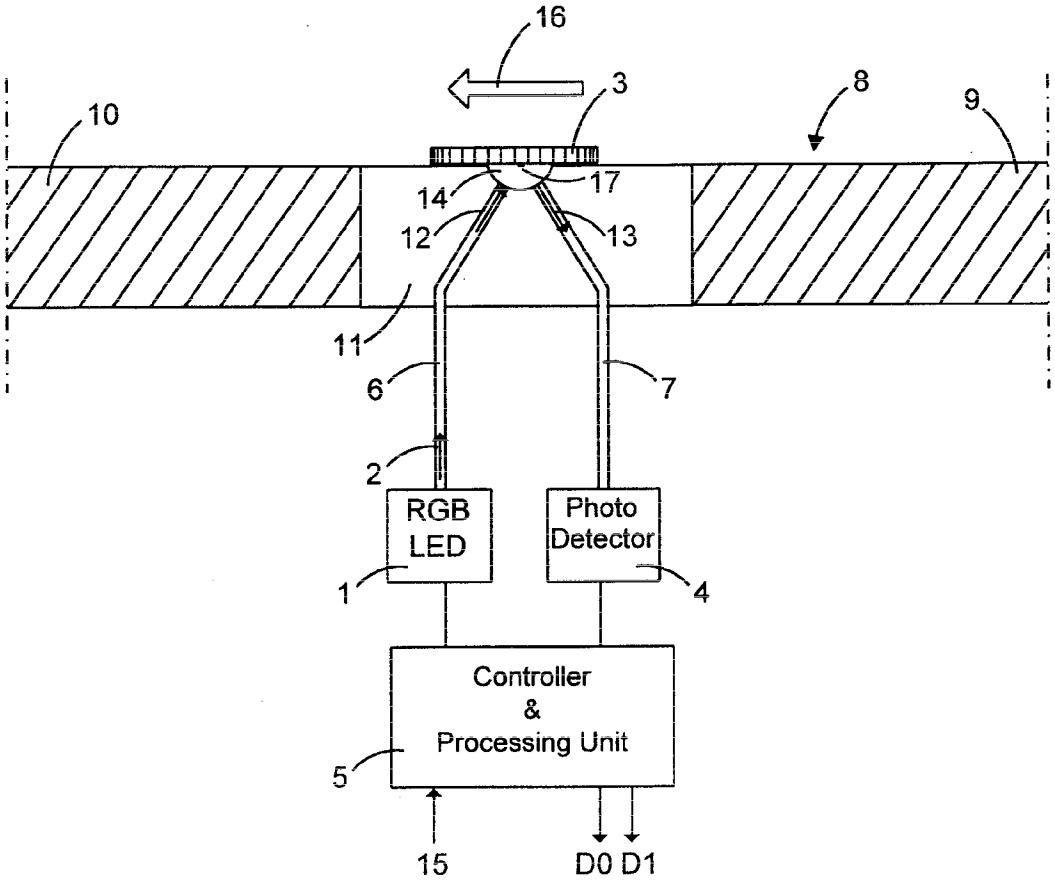

16
3
8
9
10
14
17
12
13
11
6
7
2
RGB LED
Photo Detector
1
4
Controller & Processing Unit
5
15
D0 D1

FIG 2

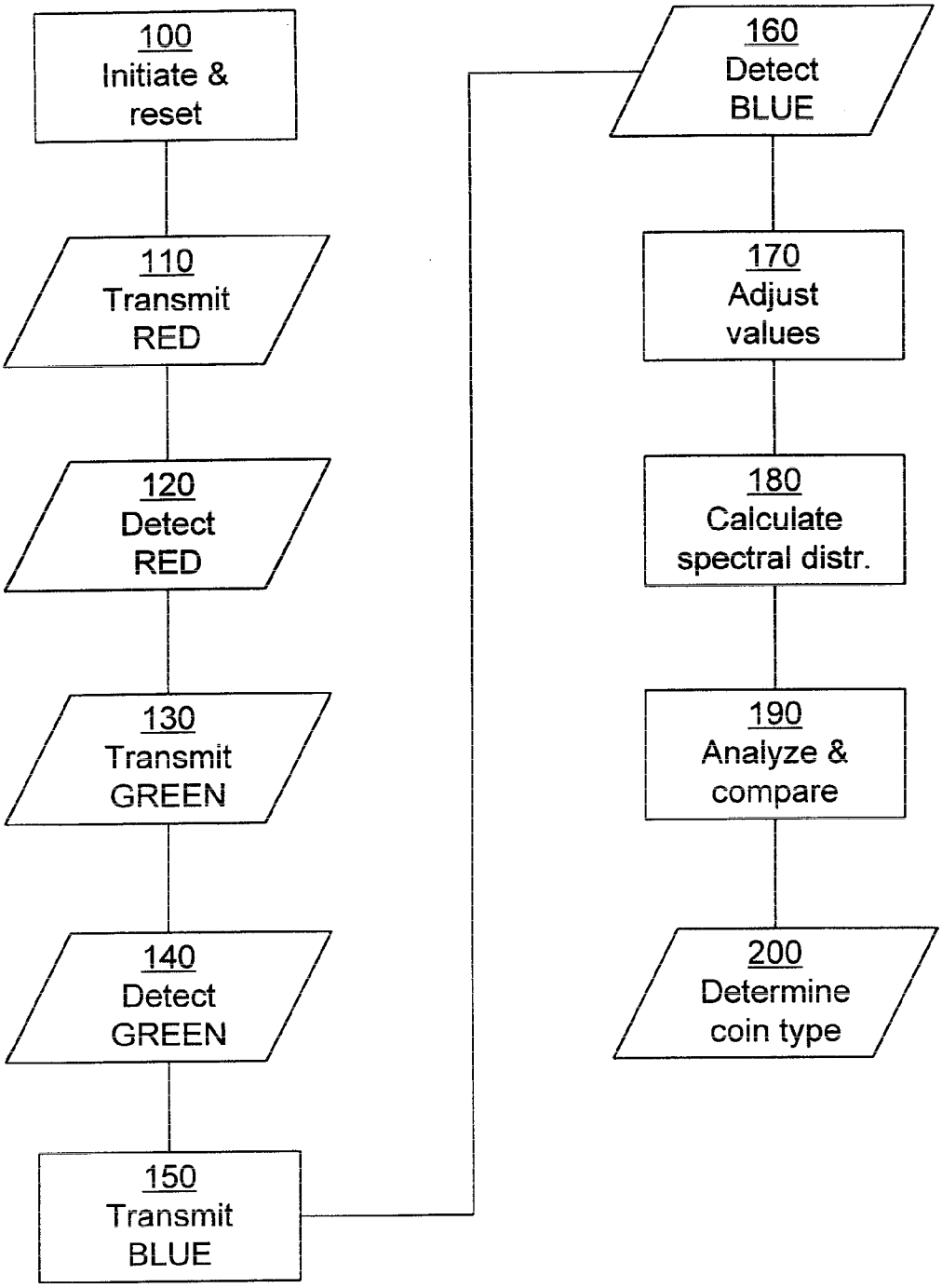
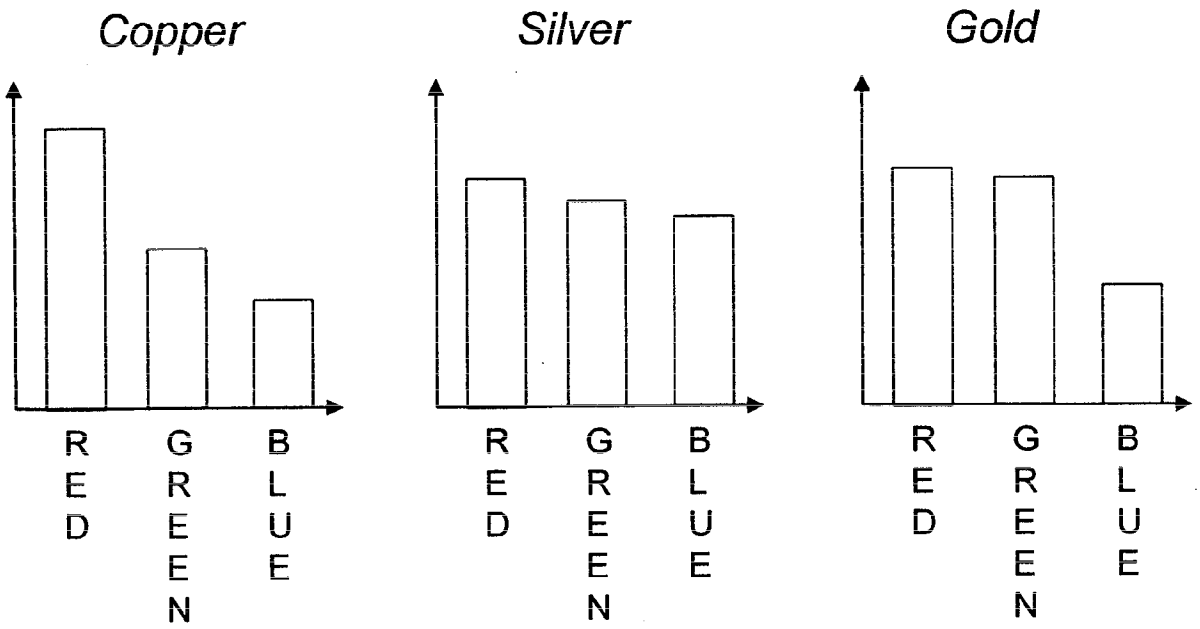

100
Initiate & reset
110
Transmit RED
120
Detect RED
130
Transmit GREEN
140
Detect GREEN
150
Transmit BLUE
160
Detect BLUE
170
Adjust values
180
Calculate spectral distr.
190
Analyze & compare
200
Determine coin type

FIG 3


Copper
RED
GREEN
BLUE
Silver
RED
GREEN
BLUE
Gold
RED
GREEN
BLUE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00015

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G07D 5/00 // B07C 5/342
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G07D, B07C, G07F, G01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	Patent Abstracts of Japan, abstract of JP 9-218968 A (GLORY LTD), 19 August 1997 (19.08.97) --	1-3,9,10,13, 14
X	WO 9623281 A1 (CHIPPER 2000 (ISLE OF MAN) LIMITED), 1 August 1996 (01.08.96), abstract --	1,2,8,10
X	WO 9634258 A1 (CHIPPER 2000 (ISLE OF MAN) LIMITED), 31 October 1996 (31.10.96) --	1,10,13

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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